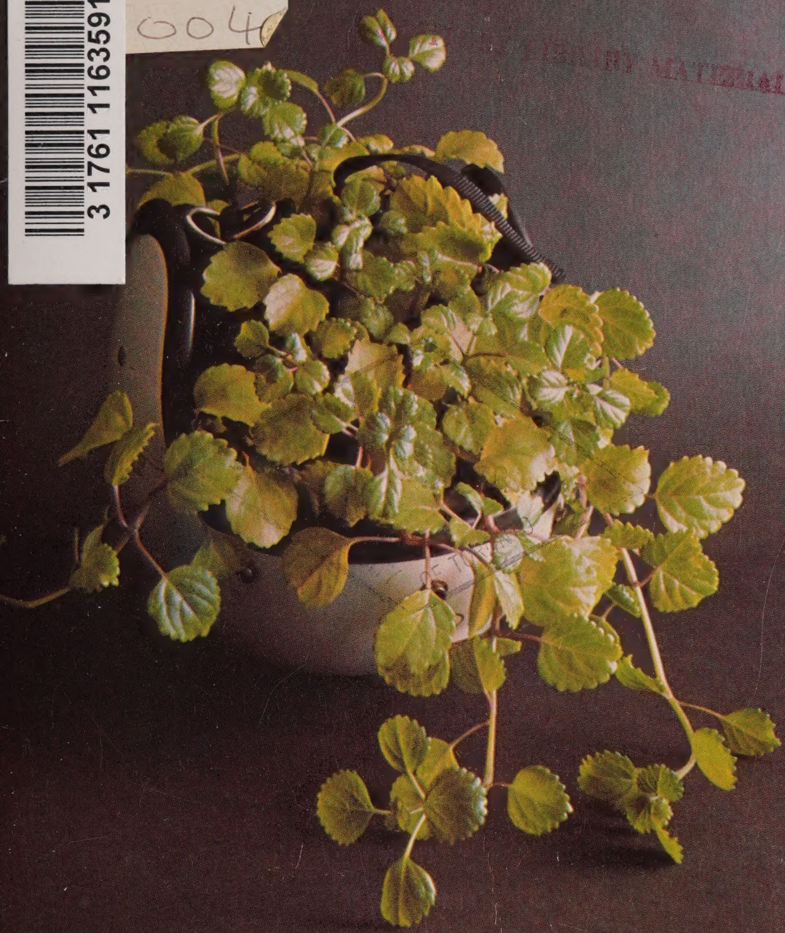
MOTORCYCLE HELMETS...



WHO NEEDS THEM?

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This report was prepared by Dr. James A. Newman, Biokinetics and Associates Ltd., Ottawa, Ontario, for the Road and Motor Vehicle Traffic Safety Branch of the Department of Transport.

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Photo Bill Petro

Introduction:

Motorcyclists are, by and large, a breed unto themselves; not usually wealthy, somewhat free-spirited, young, adventurous, often reasonably well-educated who enjoy getting from one place to another without the feeling, usually conveyed by a car, of never having left the living room. Anyone who has ridden knows the exhilaration, the sense of freedom and the feeling of oneness with his machine and with the environment.

On a less ethereal plane, it is also found that the motorcycle is a very practical way to get around. Urban planners recognize how little space a motorcycle takes up on roads and parking lots. Those concerned with the conservation of our shrinking natural resources can appreciate that a cycle consumes only about one-tenth the glass, steel and plastic of an automobile. Our petroleum producing friends would hardly be ecstatic about how one can routinely travel perhaps 30 kilometres on only one litre of gasoline (70 mpg). Economists must marvel, in these inflationary times, at being able to purchase this form of private transportation for about 20% that of an automobile. Even environmentalists must take some solace in knowing that a motorcycle, in good shape, produces less harmful exhaust emissions than the average automobile.

So far so good; but there's a catch. That sense of unity with one's machine, that we spoke of, can be shattered by anything from a few wet leaves on a curve, to a gravel truck trying to beat a red light. When that happens the cycle rider is in trouble; big trouble. Any part of the rider's anatomy that hits the road, a curb, any part of a car or truck, a post, rock, culvert or whatever, at a speed of about 30 km/h (20 mph) is going to get hurt...count on it.

Well, let's face it, a broken arm isn't the nicest thing to have, but you probably won't die from it and think of all the graffiti you can collect on the cast. A lacerated thigh is a mess, but with some stitches and proper care it will heal. Pavement burns to your backside make sitting down a problem for a while, but you'll get over it. But, and here's the other catch; a fractured skull is no fun. You could die from it and a cast on your head is not going to help. A lacerated brain is a mess and no number of stitches will help because it won't heal anyway. To have your scalp and face scraped off on the roadway is a lot worse than not being able to sit down for a while.

Before we get into accident statistics, the biomechanics of head injury, impact mechanisms and so on, consider this. If you're in an accident, even a minor one, you have more than

a 50:50 chance of hitting your head. If it is unprotected and is moving at about 30 km/h (20 mph) when it hits something solid...you are **dead**...period.

In Canada, nine of the ten provinces as well as the Yukon and Northwest Territories, all require operators and passengers of motorcycles to wear a helmet when riding on public roads: all based upon the assumption that a helmet will prevent some of these nasty things happening to your head.

In the United States every state but one has had a helmet law at one time or another. Recently, however, a wave of opposition to these laws has developed with the result that at the time of this writing, seventeen states have either fully repealed or seriously weakened their helmet laws. Furthermore, twenty or so additional states have introduced repeal bills to be considered in the current legislative sessions.

The main thrust of those opposing helmet laws has been that an individual should not be forced by the state to protect himself. The validity of this position is a matter for the courts to decide. However, in presenting their case, several valid questions have been raised concerning the ability of helmets to actually prevent serious head injuries. Indeed, it has been argued persuasively, that mandatory helmet laws can even promote injuries and fatalities.

Well, if the legislative issue is ever to be resolved, we had better, first of all, try to establish whether or not, and if so, to what extent, helmets really do prevent head injuries. That's the question we are going to try to answer in this paper.

Before trying to understand why helmets supposedly work, it is worth trying to understand something about how head injuries, in general, occur.

Head Injury Mechanisms

A human head is not unlike an egg in physcial structure. A jelly-like mass (brain) is enclosed within a hard, rather brittle shell (skull). The two are separated by a thin membrane (dura). The head has, in addition, a leathery protective outer layer: the scalp.

Head injury of the serious kind can be considered in terms of either damage to the brain or the skull. Let's consider the brain first.

Brain Injury

In order for the brain to function properly, it must not be disturbed greatly from its normal state. Its temperature, composition, chemical structure, pressure, etc., can only be allowed to change very slightly and only for a very short time before "brain damage" occurs.

A simple concussion is an example of how the brain refuses temporarily to function properly due to being "shaken-up" inside the skull. When everything settles down, the brain becomes reactivated, consciousness is regained and no significant permanent damage will have taken place. If, however, the "shake-up" is sufficiently intense, the damage to the brain can be irreversible.

To get the idea, take a raw egg (still in the shell) and let it come to room temperature. Hold it in your hand and shake it vigorously. Now, carefully break the shell open and you'll probably find the yolk broken. Something similar happens inside your head when it is violently shaken; as can happen when you leave your 350 Kawazuki and land on someone's front lawn: all this without any damage to the protective shell...the skull.

Skull Injury

Obviously, the damage to which the skull is most susceptible is that of skull fracture. If, in the previous experiment with the egg, you forgot to remove a ring you were wearing, you may have already observed this phenomenon "first hand".

Skull fractures come in assorted types but we need not deal specifically with each here. A skull fracture, like the

break of any bone in the body is not, by itself, really all that serious. With care you can crack an entire egg shell and keep the raw egg fluids inside the intact membrane. These kinds of skull fractures are generally not serious and can occur without even being knocked out. The difficulty with a fracture of any skull bone is that, if severe enough, (think again of the egg), the underlying membrane can be ruptured. When this happens, "brain drain" of the worst kind can occur. If jagged pieces of skull bone penetrate the dura and are pushed into the cranial cavity, it's almost certain that permanent brain damage will result.

So, brain damage is the problem of concern: skull fracture is incidental except that it can produce brain damage.

Injury Prevention

To prevent head injury we must therefore:

(a) minimize the violent movement of the brain within the intact skull; and

(b) minimize the probability of skull fractures.

To accomplish the first objective we must, from a mechanical point of view, minimize the energy delivered to the brain by somehow "softening" the blow. To accomplish the second we must distribute the loading over as large an area as possible. Nearly everyone has tried to see how hard he can squeeze an egg in his hand without it breaking. The trick here of course is to load as much of the shell as possible and to avoid local high-pressure points (that's why the ring should come off). Helmets attempt to accomplish both these objectives; not with eggs but with heads.

Helmet Design

The object of good helmet design is to provide as much protection from head injury as possible, consistent with the tasks the wearer must perform and with the environment in which he must function (hear the car horn, shoulder check, see the truck on his right). The most significant issue is the extent to which protective features can be traded-off in favour of human performance factors. At one extreme, one can, in theory, provide protection from all but the most severe of hazards but only at the expense of the complete loss of wearer comfort and mobility. On the other hand, one can permit complete freedom of activity if no protection whatever

is provided.

In the case of head protection, some of these activities are related to the wearer's ability to hear, to see, to speak and to be heard and to exercise head movement. In addition, the helmet must be comfortable, be reasonably priced, be aesthetically appealing and not, in itself, be a potential injury hazard.

All of the above criteria are important. None, however, relate directly to the primary function of the helmet: to protect the head against impact injury. Within this context, the helmet must reduce the injurious effect of blows of various shapes, sizes and speeds delivered to the head. It must do this under the various environmental conditions to which the helmet is exposed regardless of which part of the head is impacted. And it must do this taking into account the various sizes and shapes that heads come in.

Clearly the helmet designer/manufacturer has himself a problem. Our question is: to what extent, if at all, do his existing products meet these requirements?

A crash helmet (or safety helmet) consists of four primary elements. They are, the outer shell, an energy-absorbing liner, a layer of soft foam and fabric (the comfort liner) and some sort of retention system.

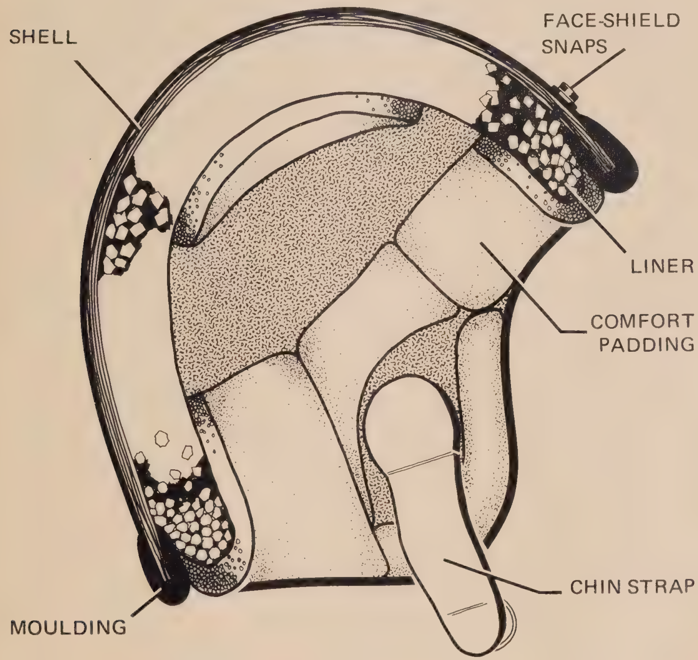


Figure 1 Section view of motorcycle helmet.

The shell is rather rigid and smooth and serves to distribute the effect of a blow to the head over as large an area as possible, thereby protecting against skull fracture. It also acts as a shield against penetration by sharp objects like rocks, bits of flying metal, car door handles, and so forth, and provides a tough abrasion-resistant surface between your head and the road as you slide along the asphalt. The shell may be made of a tough thermoplastic or layers of reinforced fiberglass. The question as to which material is better is debatable. However, for severe blows, the fiberglass shell provides an additional safety factor in that it will crush upon impact thereby soaking up some of the energy of the blow.

Soaking up or absorbing energy is really the name of the game when it comes to head protection. If some of the energy associated with a particular head impact can be used up to damage something other than the head, less is available to damage the head. Which brings us to the liner of the helmet.

The liner, usually a crushable semi-rigid foam, (a lot like the material egg cartons are made of) is the heart of the helmet. It is primarily this element that, by being partly destroyed upon impact, is supposed to stop you from taking that fast ride in the little white van with the flashing lights and sirens. The physics of the problem are quite complicated. Let's just say that, in principle, the liner shall be crushed upon impact in order that your brain not be.

Relative to the liner, the odd bits of sponge rubber and cloth throughout the inside of the helmet might seem somewhat insignificant. They are, however, important. It is these elements that ensure that the helmet is a snug and comfortable fit. Without them, the helmet would flop around on your head and, yes, may even cause you to be injured by the helmet itself.

Finally, the retention system, or to put it less formally, the chin strap: the best helmet in the world is of absolutely no use if, when you need it, it has parted company with your head. The strap is supposed to ensure that this doesn't happen. Which brings us to an important point: like not fastening the seat belt in your car, don't ever leave your helmet strap undone. Survivable accidents occur which are of such violence that riders' rings and watches leave their hands...it takes a lot less to have a helmet leave when it's undone.

Simply having a chin strap, even when properly fastened, doesn't mean that it won't break at a critical time—leaving you again unprotected—unless it's strong enough. And this gets us to the question of helmet standards and standard test procedures.

That, which is considered "good enough", is determined experimentally by standardized laboratory test methods.

Helmet Standards

Currently in Canada, helmets may be found to be certified to any of a number of different standards.

Among the more common, as indicated by labels attached to the helmets, are

CSA—D230
ANSI—Z90.1
Snell
DOT MVSS 218

CSA—D230 is the Canadian Standards Association Standard for "Safety Helmets for Motorcycle Riders". Last updated in 1970, it is presently undergoing major changes that, if approved, will make it among the more demanding standards in the world.

ANSI—Z90.1 is the "Specification for Protective Headgear for Vehicular Users" published by the American National Standards Institute.

The Snell label means that the helmet has been tested in accordance with a procedure somewhat more severe than Z90.1. Snell approved helmets are generally intended for competition use by motorcyclists and auto racers.

DOT MVSS 218 is the most recent standard to emanate from the U.S. It is the federal standard of the U.S. Department of Transportation and is considered to be a refined version of the ANSI—Z90.1 standard specifically intended for road users.

Actually all four procedures differ only slightly, but each tries to accomplish the same thing—ensure that the helmet will help save your life, or at least reduce the head injury level—if you're in an accident.

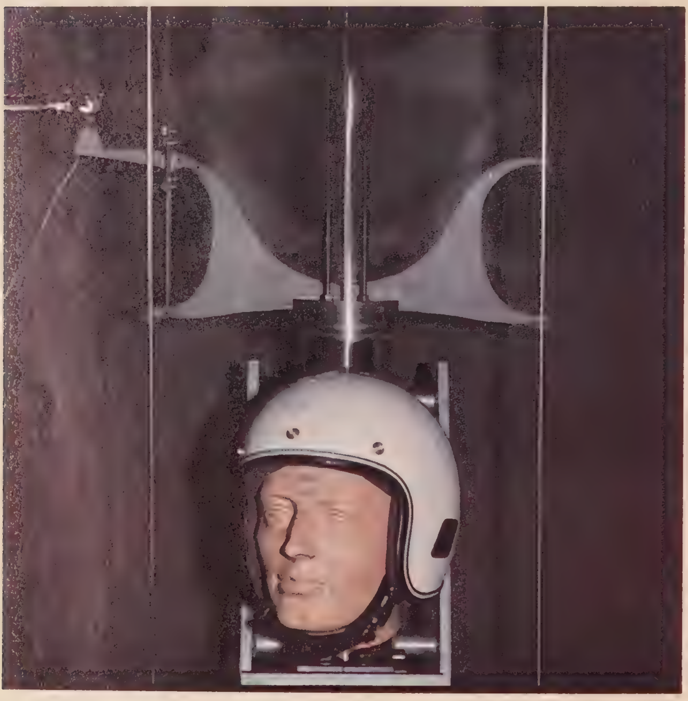
How, you might be asking yourself by now, can any laboratory test method (presumably no one is going to act as a guinea pig) evaluate the protective capability of any particular helmet? To try to answer that question let's look at, as one example, the Canadian Standards Association Standard D230.

The tests cover shock absorption properties of the helmet under various conditions of temperature and humidity; the strength of the helmet and its resistance to penetration; the strength of the retention system as well as requirements for vision and hearing, construction, finish and

materials to be used in the helmet assembly.

Just to make sure the helmet is reasonably durable before any testing is done, a helmet may be baked at 50°C for several hours, or frozen at −20°C or soaked in water all day. In fact, all three of these conditions will be investigated at one time or another.

Probably the most important test is the one for shock absorption. In this test the helmet is placed on a headform and a 4½ kilogram (10 lb.) block is dropped onto it from a height of 3 metres (9 ft.). At the moment of impact the force transmitted to the headform is measured and, if it exceeds 22,250 Newtons (N) (5,000 lbs.), that helmet, in fact every helmet of that model, is rejected. It does not get a certification sticker and it cannot be sold in Canada. If the force is less than 22,250 N it's O.K.; in fact, the lower the better. This force that is measured is, indirectly, a measure of the energy absorption capabilities of the helmet: the lower the force the more the impact energy absorbed. The new CSA standard which is in the works will place an upper limit on this transmitted force at around 15,000 N (3300 lbs.); and the impact energy delivered to the helmet will be 20% higher.



High energy impact is one thing but, if your head is struck by a sharp object, resistance of the helmet to penetration becomes equally important.

To assess this feature, each helmet is subjected to a blow by a very sharp, pointed steel striker. The 1.9 kg (4 lb.) striker is dropped from a height of 0.67m (2 ft.) onto the top of the helmet. If the point of the striker pierces the inner surface of the shell, the helmet fails the test. Without a helmet, a blow of this type would surely pierce your skull.

Abrasion resistance will also be incorporated in the new standard. In this test, the equivalent of a high-speed belt sander is loaded against the shell. The drag on the shell and the rate at which the shell wears away are both monitored.

The other important test is for the strength of the chin strap. Here the helmet is placed on a headform, the strap passed through a set of rollers simulating the cheeks and jawbone and a load of 890 N (200 lbs.) is applied. If the strap breaks or even stretches more than 2.5 cm (inch), that's bad news for the manufacturer. Again, the whole line of helmets fails.

The proposed standard for chin strap strength raises this requirement to 2,000 N (nearly 450 lbs.) without failure occurring.

There are many other things that are looked for, any one of which could result in a helmet being rejected, but the above are the main performance tests. If, after all this, the helmet has passed everything, the label goes on and you as a motorcycle rider can be reasonably sure that you're getting a good product.

Great. So much for all the theory but do helmets really do the job when worn by real people in real accidents? There's a no-more-used cliche but, "the proof is in the pudding". In this case, the "pudding" is the statistical data compiled that deals directly with motorcycle accidents, injuries and fatalities. Let's have a look at it.

Accident Statistics:

Before getting into this numbers game, let's keep in mind one thing. Statistics are facts. Those that attempt to draw conclusions from the observation of these facts are often charged with selecting only those facts that support that which they have already concluded. As Benjamin Disraeli put it: "There are lies, damned lies and statistics."

To examine the effect of mandatory helmet usage we could examine the records of provinces which have helmet laws and those that don't. But, it could be argued, factors

other than helmets could be the reason for any differences found. Furthermore, on what basis do we judge the effects of helmets? On the number of injuries or fatalities per registered motorcycle? Per average mileage travelled each year? Per accident? When we look at the numbers of persons injured, isn't it possible that some of them were pedestrians struck by a motorcycle? (Should they wear helmets too?) Isn't it possible that the accident victims became injury statistics from something other than **head** injuries? What about the accidents that don't get reported? What about the off-road bikes that are not registered? What about the injuries that were treated by physicians who never knew that they were the result of an argument between a motorcycle and a ditch full of rocks?

First of all, the only figures available are those based on registration data from the various provincial motor vehicle licence bureaus and on official police accident reports. The registration data includes only those vehicles that were actually registered and not mini-bikes, trail bikes, and the like. In each province, every year, there are perhaps 10% more motorcycles than "official" figures would indicate.

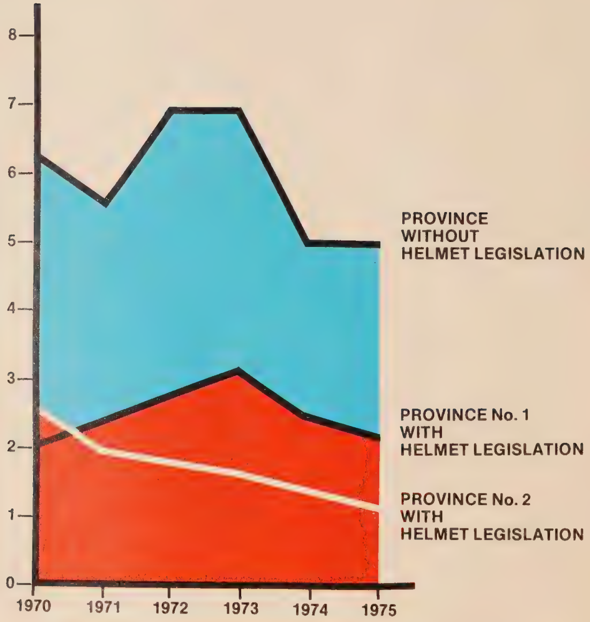


Figure 2 Reported accidents per 100 registered motorcycles.

With respect to "official" accident statistics, a very important factor must be kept in mind. An accident statistic is only that if the accident results in an injury and/or property damage, **and is reported.** A rider who loses it, has a friend cart the remains of the bike off in his pickup and takes him home to nurse his wounds **will not appear in those figures.**

Now, regarding the interpretation of statistics in general, the following basic rules must be adhered to:

(a) When trying to determine the effect of a certain variable (such as the use or non-use of helmets) one must be sure that no other variables are also changed. The seat belt interlock system on new cars and the 55mph speed limit in the United States resulted in a marked reduction in the number of automobile fatalities. But, because two variables (seat belts and speed limit) were both changed, it was not certain which particular measure was most responsible for this effect.

(b) The size of the sample examined must be large. Large enough that any conclusions that might be drawn, would be generally true for the entire population. This, of course, is a relative figure and must be treated with some care. A survey in your school or office on, for example, how many people would favour mandatory helmet laws, could probably not be used to reflect the attitude of the entire country. On the other hand, the opinion of one class as to who is the best teacher in the school would probably be a good indication for that entire school.

(c) The statistical data must be complete, accurate and consistent. This may seem obvious but, when not properly accounted for, can lead to all sorts of problems. As an example, if there were twice as many domestic animals in Saskatchewan as in Newfoundland, one could not conclude that there must, therefore, be twice as many cats. The data, though perhaps accurate, is too generalized to be **consistent** for such a conclusion.

The point in spelling out all these rules is to make it clear why one can't automatically compare, for example, Prince Edward Island to New Mexico, or even Nova Scotia to British Columbia. In fact, when one examines all the data from all the provinces and the territories, much of it must be excluded from consideration because of non-conformity with one or more of the above rules. In the final analysis, there are, however, a few indicators of the value of helmets.

In Nova Scotia, the number of persons killed due to motorcycle accidents dropped by 30% the year after its helmet law was introduced. The numbers, however, were rather small.

In Quebec, the province with the largest number of motorcycles in the country, the number of cyclists who died from head injuries dropped from 95 to 75 the year (1974) that mandatory helmet usage was enforced; even though registrations rose by 10%.

In the prairies, where one province does not enforce helmet use, that province from 1970 to 1974 had 2 to 2½ times as many head injury fatalities per registered motorcycle as its "helmet-law" neighbours.

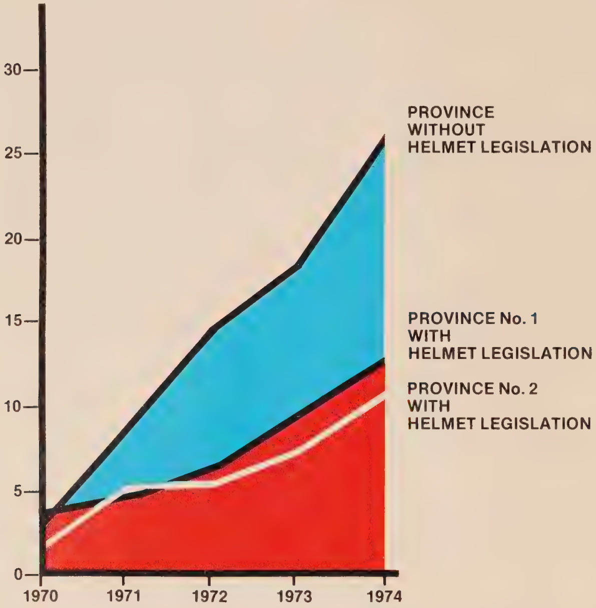


Figure 3 Total number of head-injury fatalities since 1970/average 10,000 registered motorcycles.

These facts certainly suggest that the use of a helmet does reduce substantially the likelihood of the wearer sustaining a fatal head injury in a motorcycle accident. But is that all? What about non-fatal head injuries?

Statistics are of no value here because injuries are not usually tabulated in official records. To obtain such data, one must search either hospital records or examine the data of in-depth accident investigation programmes. Here's what one would find.

If a helmet is not worn and the head is impacted, the chances of sustaining a minor head injury are **twice** that of when a helmet is worn. You are **three times** as likely to sustain a so-called moderate head injury and **four times** as likely to sustain a serious head injury!

Well now, that's not bad! Makes wearing a helmet seem like a pretty good idea. But that's still not the whole story.

Upon further examination of the statistics for the prairies, a rather interesting fact would become apparent. **The "no-helmet law" region had, from 1970 to 1975, 2½ to 3 times the number of accidents per registered motorcycle than its "helmet-law" neighbours!**

Does this mean that by not having a mandatory helmet law, the probability of being in an accident is that much higher than if there was one? What's the connection between wearing a helmet and having an accident?

The answer to the first question is a qualified, "yes." The qualifications relate to the definition of an accident. To understand the connection between the accident and the helmet, put yourself in this situation....

It's a pleasant afternoon in the Fall. You're riding home from work in the right-hand lane of a 4-lane road. Traffic's fairly heavy but moving at about 65 km/h (40 mph). A car is beside you in the left-hand lane.

You are perhaps thinking about what you've planned for this evening or just musing over the events of the day. Suddenly, the car on your left starts to move into your lane crowding you. You sound your horn but in his air-conditioned, insulated Supergaz GT Chargerino he doesn't hear anything but the latest disco special on his tape deck.

He's still moving over. It's too late to accelerate past him. You brake hard and lean your machine to the right. At that instant your front wheel hits a slick spot and as you go down to the sound of screeching rubber and metal scraping on asphalt, you pray that no car is so close behind that you're about to get run over. You feel your right thigh sting as it contacts the asphalt, then there's a loud crack as your helmeted head is whipped down onto the pavement. You finally slide to a stop.

After what seems like several minutes, the driver of the car behind, who had been able to brake in time, comes to see if you are alright. You get up; and bend down again to turn your bike off. It's still in gear and somehow it looks silly lying there with the back wheel spinning around. You explain in a shaky voice that you're OK, brush yourself off, pick up your bike and push it to the side of the road.

Soon the traffic begins to move again. The few that saw what took place sort of shake their heads and move on. By now our air-conditioned friend is long gone—not even realizing how close he came to causing the death of a fellow motorist.

Since you had been wearing a helmet, the result of this little encounter is a few scrapes and bruises, considerable embarrassment and a lot of anger.

The point of this scenario is that **no accident is reported.**

Had you not been wearing a helmet, chances are they would have found you flat on your back, out cold and bleeding from one or both ears. Someone would have called an ambulance and the police. You would have become **a single vehicle accident statistic.**

That is why "no-helmet-law" regions have three times as many reported accidents as similar "helmet-law" regions. Yes, helmets prevent accidents—the ones which, because of no head injury, are not reported.

Conjecture, you might be thinking. Where are the statistics on these kinds of accidents that aren't "official" acccidents? There are none of course—except for those provided by motorcyclists themselves.

Perhaps you've heard of the "Saved by the Helmet Club", a voluntary club sanctioned by the Safety Helmet Council of American (SHCA.) Members of this club, and there are many, are all motorcyclists who believe that, because they wore a helmet at the time of their accident, they avoided serious or fatal head injury. **Nearly ⅔ of the members were in accidents that were not police reported.**

If you're still not convinced, try this one. In a hospital record study of all the victims of motorcycle accidents in a large county in California during 1970, less than 40% of the injured motorcyclists were found in "official police records". Why? Because those that were conscious, and since no other vehicle was involved, probably asked a friend or passerby to take them directly to the hospital. When you're unconscious or dead, you can't do that and that's when your accident becomes "official".

But, as flowers must have rain, as cars produce air pollution and as reading this article causes eye strain; with the good comes the bad. Let us now consider all the potentially bad things about helmets and see if any warrant recommendations against their use. Again, let's stay with facts when presenting these arguments.

The Anti-Helmet Case

The following arguments are not presented in any particular order.

Argument 1: The wearing of a helmet impedes the wearer's vision.

The Facts: Certified helmets provide a field of view of at least 210° from side to side. Sunglasses are more restrictive in all directions.

Conclusion: Argument not supported.

Argument 2: The wearing of a helmet reduces the wearer's ability to hear potentially important sounds in the traffic environment.

The Facts: A given sound will be heard by a cyclist only if it is louder than other sounds present at the same time. If a particular sound is audible above engine, wind and traffic noise, it will also be audible when all these sound levels are suppressed somewhat by using a helmet— Otherwise, it will not be heard in either case.

Conclusion: Argument not supported.

Argument 3: Using a helmet reduces the wearer's ability to execute rapid head movements so important in heavy traffic.

The Facts: The neck muscles soon accommodate to the approximately 20% increase in weight due to the wearing of a helmet. There has never been a documented accident case where this reason was the cause of the accident.

Conclusion: Argument is conceivably valid if helmets were to become excessively heavy.

Argument 4: Helmets are hot and could cause excessive perspiration which might trickle into the cyclist's eyes hindering his vision.

The Facts: There is no evidence to support this contention. There has not been a documented accident for which this was the cause.

Conclusion: The argument is conceivably valid, but has never been documented.

Argument 5: Neck injuries increase amongst accident victims wearing helmets.

The Facts: The **proportion of injured cyclists** that sustain neck injury is higher (about twice as high) where a helmet is used. So are the proportions of arm, leg, and chest injuries. The reason is that, since all injured cyclists sustained some injury and since, for the helmeted group fewer had head injuries, other regions of the body were injured instead of the head. To deduce from this, however, that helmets cause injuries is incorrect. Concern must be with the number of cyclists in **accidents,** not just those who were injured. About half of those wearing a helmet sustain no significant injury. When looked at in this light, it is obvious that helmets do not generally cause neck, or any other kind of injury.

In a recent Maryland study based on pathological findings of 96 fatally injured motorcyclists, absolutely no association between neck injuries and helmet use was revealed.

Neck injuries are rare among motorcyle accident victims (about 2%).

A New York study of motorcycle accidents conducted in 1969 of injury data for 1966 (before mandatory helmet law) and for 1967 (after the helmet law) found that 4 of the 87 fatalities in 1966 were due to neck fractures, while 14 of the 52 fatalities of 1967 were due to broken necks. That this increase in fatal neck injuries can be attributed to the introduction of mandatory helmet usage (a conclusion not reached by the investigators) is erroneous. Virtually all the rules of statistical analysis are violated:

(a) The number of cases is not "large";

(b) The data are inconsistent and inaccurate. The data were collected from police and coroner reports **not** from autopsies conducted by medical personnel on the victims. The consequence of this is that the observed presence of a massive skull fracture on a fatality would likely be listed as the cause of death whether a broken neck was observed or not. If the hel-

met prevented major head injuries, the search for the cause of death might reveal a fatal neck injury; and

(c) The injury data were incomplete. Only 69 of the 87 fatalities for 1966 were examined and only 37 of 52 for 1967.

Other studies of accidents in Japan, Australia, France and Canada, have found no significant evidence that helmets cause injuries of any kind.

Conclusion: Argument not supported.

Argument 6: Helmets provide a false sense of security, causing wearers to behave with less caution and thus are more likely to be in an accident.

The Facts: Helmets provide a **real** sense of security.

On the basis of "official" accident reports, helmet wearers are **less** likely to have an accident. In the same New York study referred to earlier, there were 5,184 accidents in 1966, only 3,161 in 1967. To be fair, however, it is possible that there may have been other reasons for the saving of over 2,000 accidents and, of course, there are also the "unofficial" accidents we talked about earlier.

With respect to the wearer's behaviour, immunity from physical harm may invoke a sense of agressiveness.

Conclusion: Helmets provide **real** head protection.

Data does not support the argument that helmet use increases accident likelihood due to more reckless driver behaviour.

Using a helmet is a safety precaution. But it will not prevent a ruptured spleen, a broken back or a punctured kidney. Cautious, safe-riding habits, coupled with a sense of one's own vulnerability on a motorcycle must be practised—always.

Wearing a helmet may save your head; saving your life is largely up to you and how you ride.

Case Studies

The following brief descriptions of motorcycle accidents have been extracted from the files of the Motorcycle Crash Investigation Unit at the University of Ottawa.

This group, composed of researchers with backgrounds in vehicle accident investigation; mechanical and civil engineering, orthopaedics, sociology and with experience in motorcycle training programmes, investigated in depth, 271 accidents in the National Capital Region.

Members of the research team, all but one of whom was a motorcyclist, were on call 24 hours a day, 7 days a week during the summers of 1973 and 1974. Most accidents were investigated on-site immediately after the accident, notification having been received via police dispatcher.

At the site, the police investigating officer, witnesses and in most cases the victims were interviewed. The scene and the vehicles involved were carefully examined and photographed extensively.

In those cases where injuries occurred, medical reports were compiled by the physicians associated with the investigation unit. In addition, in those cases where head impact had occurred, the victim's helmet was acquired for subsequent examination. Later, new helmets of the type involved in the accidents were impacted in the laboratory to try to duplicate the damage to the accident helmet. This provided some insight into "how hard" the person's head was struck.

The cases presented below are all "success stories". There simply were no cases in which the use of a helmet did not prevent more serious injury. The cases were chosen on the basis of a confirmed head impact and are representative of the kinds of accidents that occur.

Case #17

Motorcyclist was trying to beat a yellow light and collided with the front-right corner of a light truck which turned left into the path of the motorcycle.

Approximate speed at impact—65 km/h.

Operator was ejected up (as high as the traffic lights according to one witness) and over the hood of the truck, landing on his head and face, 10 metres from the point of impact.

Impact to helmet was severe enough to crack the polycarbonate shell.

Victim sustained severe facial injuries—no skull fracture; no brain damage.

Case #36

Motorcycle was making right turn on exit ramp from divided highway. Speed approximately 95 km/h. Vehicle hit sand patch and began to slide from under operator. While attempting to regain some control, vehicle struck curb and the operator was ejected. Operator struck front of head on pavement of adjacent road 3 metres from point of ejection then slid and rolled an additional 30 metres.

Victim sustained abrasions to left shoulder and arm, and broken arm. No head injury.

Case #51

Accident similar to No. 36 but to the left. Speed approximately 80 km/h. Upon vehicle striking curb, operator was ejected into and then over a guard rail. His helmeted head struck a bolt protruding from the rail structure.

Victim sustained facial lacerations and fractured right forearm. No head injuries.

Case #130

Motorcycle travelling at about 80 km/h. along a main highway pulled out to pass the car ahead. While passing the car, it, in turn, pulled out to pass the car ahead of it, forcing the motorcyclist off the road at over 110 km/h.

Motorcycle operator lost control and struck his head with such force as to tear the helmet from his head. He continued to roll and slid an additional 25 metres conscious all the time that his helmet was gone saying later that he deliberately kept his head up during this time. He suffered no further head impact.

Victim sustained facial and leg lacerations and badly scraped shoulders—no skull fracture; no brain damage.

Case #208

Police motorcyclist was about to proceed through a green light at about 40 km/h. A car ran the red light to his right. The motorcycle (with side-car) struck the left-front quarter of the car and the officer was thrown over the hood, landing on his head and right shoulder about 4 metres from the point of impact.

Victim's injuries were limited to a very stiff neck for a few days.

Case #236

Motorcycle operator lost control of machine at a speed of about 80 km/h. and ran head-on into a large truck (closing speed about 110 km/h.) Victim was ejected up and into right-front side of truck.

Many serious injuries were sustained including a neck broken in two places and 25 other fractures. His helmet was badly damaged in the accident yet there were no head injuries and the victim survived.

Case #247

Motorcycle was proceeding straight ahead toward an intersection at about 65 km/h. About 10 metres from the corner, a van coming from the opposite direction turned left directly into the motorcycle's path. Motorcycle crashed into van and operator went head-first into its side. He rebounded back onto the road striking his head again.

He was unconscious for half an hour. He sustained no fractures and no permanent brain damage.

Case #267

Motorcycle was proceeding straight ahead at approximately 70 km/h. A car pulled out from a side street directly into the path of the motorcycle. The motorcycle skidded into the mid-section of the car at about 65 km/h.

Operator was ejected up and into the side of the automobile, then flew an additional 10 metres beyond the point of impact, striking the ground with his right side and head.

The victim broke both arms and legs and sustained severe bruises and scrapes over his body. He was unconscious for 15 minutes.

He sustained no skull fracture and no brain damage.

Cases #97 and 274

These two cases are presented together as they provided a reasonable comparison of the differences between wearing a helmet and not.

Both motorcycles were proceeding straight ahead when cars coming from the opposite direction turned left into their paths.

Both operators were wearing helmets prior to the collision. Operator 274, however, **did not have the strap done up** and, at impact, it came off his head.

No. 97	No. 274
Speed at impact 65-70 km/h. Operator went into side of car then ejected over it landing 10 metres from the point of impact striking his head.	Speed at impact approximately 80 km/h. Operator went into side of car but with somewhat less violence than operator 97. He was ejected over the car and landed 12-14 metres from point of impact striking his head.
Victim sustained broken arm and leg and severe bruises to the chest and pelvis. He sustained no head injuries.	Victim sustained bruises and scrapes all over and severe permanent brain damage.

So, there are the facts and a reasonable interpretation of them. The conclusions are obvious. Helmets save lives. Helmets prevent head injuries and, indirectly, helmets prevent accidents.

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